PATENT SPECIFICATION

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535,566

No. 7910/40.

COMPLETE SPECIFICATION

Improvements in or relating to a Thermal Protective Device for Rotating Heat Engines

We, MASCHINENFABRIK OERLIKON, a body corporate organised under the Laws of Switzerland, of Oerlikon, near Zürich, Switzerland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a thermal protective device for rotating heat engines.

It is known that the efficiency of heat engines such as for example, turbines, increases with the temperature and that, in particular, gas or hot air turbines work economically only at temperatures lying above 500° to 600° C. The higher the temperatures that can be employed, the more economical such machines become.

Two important demands are made of the materials intended for use in the construction of machines operated at high temperatures. Firstly, they should have adequate strength, in order to withstand the stresses occurring during operation (for example on blades and wheel discs); secondly, they should be free from scale, that is to say no oxidation, which would lead to the scaling off of the material, may take place at the surfaces of contact between the material and the hot working medium.

The use of temperatures of any desired level has hitherto been limited by the properties of the materials available, since the mechanical strength properties of such materials are no longer adequate at temperatures above 600° C., although in respect of freedom from scale, materials are already obtainable at the present time which are satisfactory up to 1000° C. and higher, but only when they are not subjected to stress.

It is moreover known to cool by water circulation the supporting materials, particularly the blades of turbines, and thereby to keep their temperatures within permissible limits. Such cooling of the blades, particularly the impeller blades, however, involves various disadvantages. In the first place, it is difficult to seal the water admission channels, and secondly, in the case of water cooling, a large temperature drop occurs over a short distance within the supporting parts, which is detrimental to the strength of the supporting parts, and finally the intensity of the cooling is restricted by the great withdrawal of heat which may have a detrimental influence on the efficiency of the entire plant.

The present invention aims at obviating the foregoing drawbacks.

To this end, according to the invention, the materials used in rotating heat engines which are subjected to mechanical stresses are covered with a layer of a heat-insulating material. By this means said materials are excluded from the zone of the main temperature drop, on the hot side, and then have a fairly constant overall temperature and can therefore be stressed like ordinary materials.

In addition to the advantage of the elimination of complicated cooling devices, it is possible, by suitably amply dimensioning the heat-insulating layer, to minimise the heat losses. The withdrawal of heat in the natural way through the shaft and bearings can suffice to keep the temperature of those protected parts within permissible limits. By the provision of ribs, the withdrawal of heat to the surrounding atmosphere can be improved. Finally, more remote parts, which are more easily accessible to a stream of cooling medium than the impeller and guide members, for example the shaft or the disc hub, can also be provided with artificial cooling. The provision of a heat-insulating layer for the vital parts is now possible as thermally stable protective materials, which withstand the temperature of the hot working medium and are self-supporting are available for the protection of said heat insulating layer. It is convenient, as far as possible, to convert the tensile stresses of these protective covers into compressive stresses. Thus, for example the moving blades are made with head bands which take the tensile stress of the heat insulating material and heat-resistant protective material and convert the same

into compressive stresses.

The reduction of the temperature of metal parts by insulation can be effected according to the invention, on the rotating and stationary parts of the turbine. The protection of the insulation by heat-resistant metal covers can be dispensed with at certain points, particularly on the stator. The heat-insulating material can be applied to the supporting or protective metal or can be inserted or pressed in between the two. The protective material can also be applied by a spraying process.

In order to enable the invention to be more readily understood, reference is made to the accompanying drawings, which illustrate diagrammatically and by way of example, several embodiments thereof, and in which:—

Fig. 1 is a section of a rotor with blading;

Fig. 2 is a section through a rotor blade looking towards the head band.

Fig. 3 a section through two rotor blades looking towards the intermediate cover members at the disc rim.

Fig. 4 a longitudinal section through a rotor blade;

Fig. 5 a section through a guide apparatus; and

Fig. 6 a section through a guide blade.

In Fig. 1, 1 denotes the shaft, 2 the rotor and 3 a rotor blade, which may be made of material having good hot strength or of ordinary material. The blade root 5 is inserted in the rim 10 of the rotor disc 2, or the blade and disc may consist of one piece. The head band 6 is made integral with the blade 3 and both disc and blade are coated with a heat-insulating layer 7. This layer can consist of solid material placed over the supporting blade and disc or may be sprayed on to said parts. If the insulating layer 7 can be durably fixed, it will itself be sufficient without additional protection. Although in Fig. 1 water cooling of the disc is provided in the hub 4 in order to promote the withdrawal of heat; nevertheless this is not essential, since, given adequate thickness of the heat-insulating layer 7, the temperature of the supporting blade and disc can be kept sufficiently low without such cooling.

In order to protect the insulating layer 7 from the effects of the flowing working fluid and of the rotation, a protective layer, consisting of the parts 13, 14, 9, 12 and 11, is placed over the layer 7, this layer being of thermally stable material. The individual parts of the protective cover can be welded together at their edges, as indicated in Fig. 1. The protective cover 9 preferably has a clearance against the rim 10 of the disc, in order to be able to expand freely; it is subjected to compressive stress by the centrifugal force. The centrifugal forces of the protective covers 9 and 11 are taken by the head band 6 of the cold supporting blade 3. The two protective covers 13 can expand freely downwards; they are best designed as discs of equal strength.

For the protection of the heat insulation on the outer rim of the disc, use is made of the cover parts 14 (Fig. 3) placed between the blades 3; these cover parts are welded to the cover discs 13 on both sides.

In this manner the supporting disc 2 and the supporting blade 3 are protected by a heat insulation 7, and the latter is protected by a thermally stable material against impact from the working medium and centrifugal forces, while conversely the centrifugal forces in the insulation and protective materials are for the most part taken up in turn by the cold supporting material 2 and 3. Such a construction can therefore be subjected to working medium of substantially higher temperature than an ordinary blade of good hot strength, without this advantage being gained at the expense of complicated water cooling arrangements or great heat losses.

The protective cover 11 can also be omitted if desired. As the small unprotected face of the blade does not receive any impact from the working medium, the insulation is subjected to less stress at that point.

Finally, not only the protective cover, but also the insulation, can be omitted at the end faces, as the small face of the supporting blade can absorb only a little heat which, given adequate withdrawal, maintains the temperature at the face at permissible values. In this case, cooling air may be passed along the unprotected faces of the supporting blades or also over other unprotected parts.

Figs. 5 and 6 show a guide apparatus or a guide blade protected on the same principles. 15 is the blade of material of good hot strength or ordinary material, 16 the insulation and 17 the protective cover, 18 and 19 are the protective sheets of heat-resistant material of the guide disc; they enclose the insulation 20 which protects the disc 21.

The structural arrangements may be of any desired type; the protective covers may, for example, be held on the foot between the blade and the disc.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we

claim is:—

1. A thermal protective device for rotating heat engines such as turbines, in which the materials subjected to mechanical stresses are covered with a layer of a heat-insulating material, which is in turn protected from the surface action of the working medium by a material stable to heat.

2. Protective device as claimed in claim 1, in which at least part of the centrifugal force of the heat-insulating material and of the material stable to heat is taken up by the protected material.

3. Protective device as claimed in claim 1 or 2, in which at least some of the supporting runner wheel blades of a turbine are provided with a head band which takes the tensile stress of the heat-insulating protective material in such a manner that the tensile stress is converted into a compressive stress.

4. Protective device as claimed in any of claims 1 to 3, in which the head band is covered with a heat-insulating material and a thermally stable material.

5. Protective device as claimed in any of claims 1 to 4, in which the centrifugal force of the heat-insulating material and of the heat-stable protective material of the head band is taken up in the protected blade.

6. Protective device as claimed in any of the preceding claims, in which any parts of the protected material not provided with heat-insulation are externally cooled by means of a cooling medium.

7. Protective device as claimed in any of the preceding claims, in which at least some of the rotor discs or drums are covered at least partly with a heat-insulating material and a heat-stable material.

8. Protective device as claimed in any of the preceding claims, in which a heat-insulating layer is provided at the roots between the rotor blades, said layer being protected by distance sheets of heat-stable material, which in turn are joined to the lateral protective covers of the disc.

9. Protective device as claimed in any of the preceding claims, in which the guide wheel blades and discs are partly covered at least with a heat-insulating material and a heat-stable material.

10. Protective device as claimed in any of the preceding claims, in which the heat-insulating material is applied by a spraying process.

11. Protective device as claimed in any of claims 1 to 9, in which the heat-insulating material is applied by a pressing process in a liquid state.

12. Protective device as claimed in any of claims 1 to 9, in which the heat-stable protective material is applied by spraying.

13. The thermal protective device for rotating heat engines, constructed, arranged and adapted to function, substantially as described, with reference to the accompanying drawings.

Dated this 2nd day of May, 1940.
ALBERT L. MOND & THIEMANN.
14 to 18, Holborn, London, E.C.1,
Agents for the Applicants.

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[This Drawing is a reproduction of the Original on a reduced scale.]

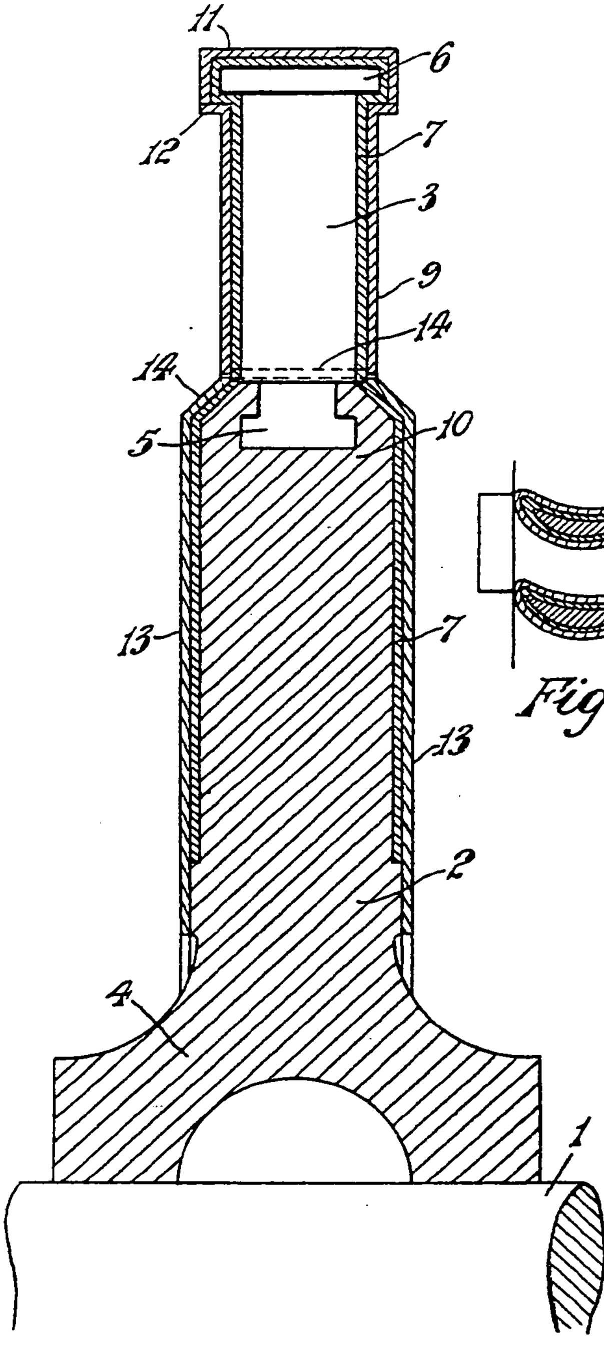

Fig.1.

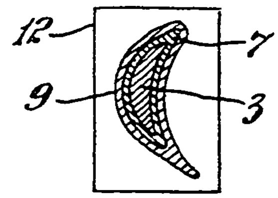

Fig.2.

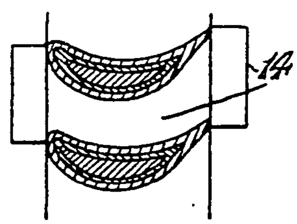

Fig.3.

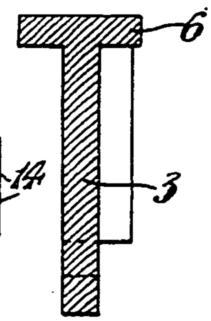

Fig.4.

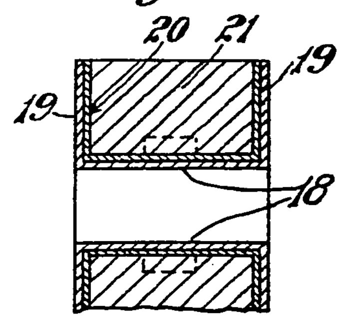

Fig.5.

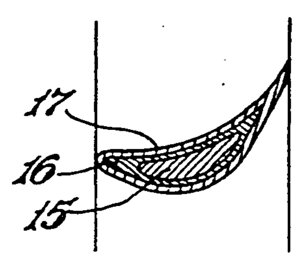

Fig.6.